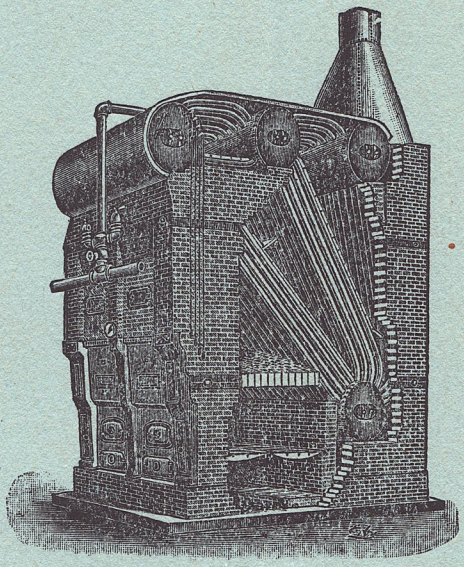
# THE STIRLING

# WATER TUBE SAFETY BOILER.



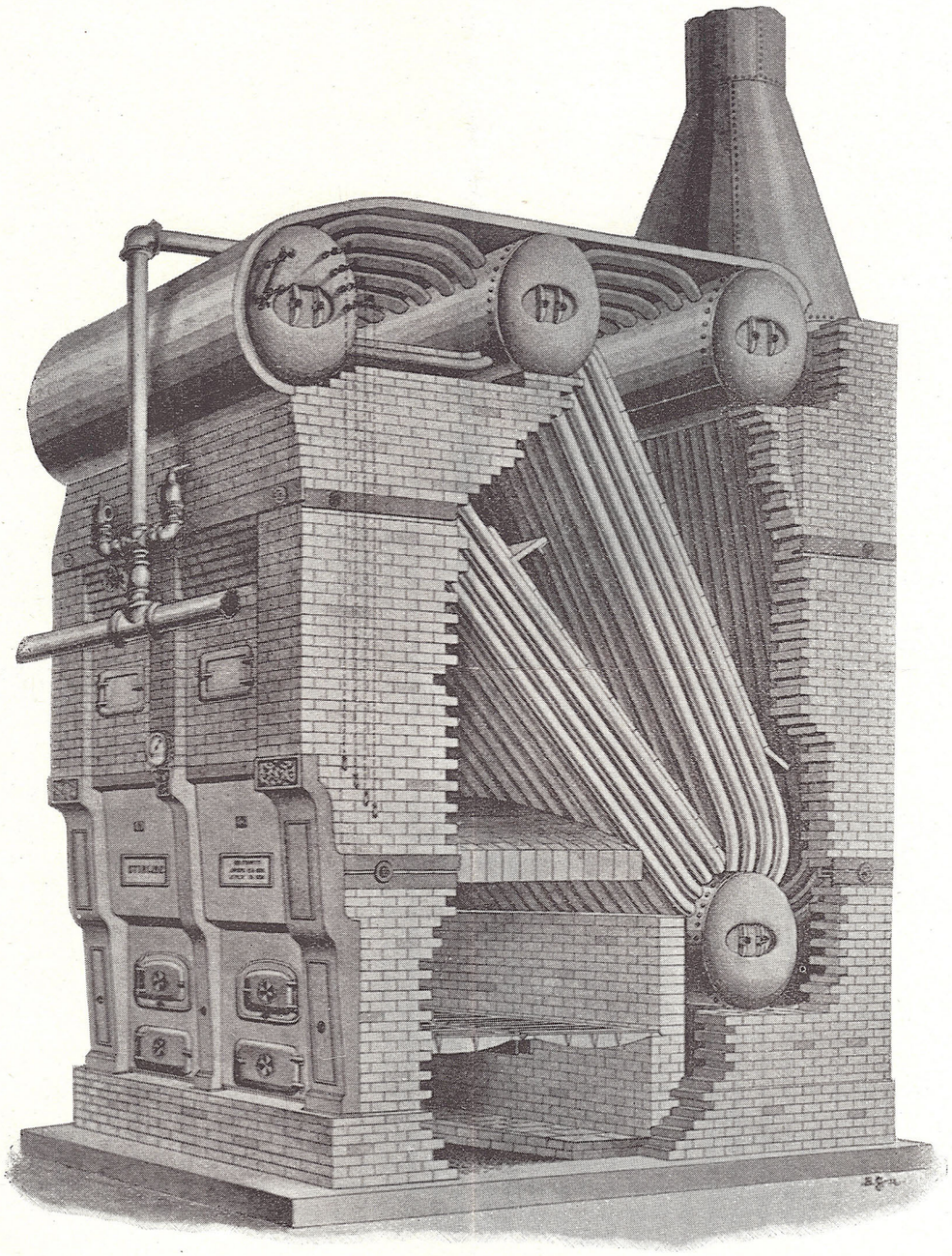
## THE STIRLING COMPANY,

**GENERAL OFFICES:**

**FULLMAN BUILDING, CHICAGO.**

ALFRED CRESSEN, 1310 18th Street, - DENVER, COLO.

# THE STIRLING BOILER.



Manufactured by

## THE STIRLING COMPANY.

NEW YORK:
74 Cortlandt St.

PITTSBURGH:
Lewis Block.

CHICAGO:
Pullman Building.

ALFRED CREBBIN, 1310 18th Street. – DENVER, COLO.

O. C. BARBER, President.
CHICAGO.

THOMAS DEEGAN, Sec'y and Gen'l Mgr
CHICAGO.

J. K. ROBINSON, V.-Pres.
CHICAGO.

C. W. CRANKSHAW, Treasurer,
CHICAGO.

H. S. PELL, Superintendent,
SHOPS, BARBERTON, O.

# THE STIRLING COMPANY

General Office: Pullman Building,

CHICAGO, ILL.

## SELLING AGENTS:

S. E. KEELER, 74 Cortlandt St. - - - New York City.
J. H. HARRISON & CO., Lewis Block, - - Pittsburgh, Pa.
JAMES MEILY, 418 Walnut Street, - - - Philadelphia, Pa.
C. G. BLAKE, First National Bank Building, - Cincinnati, Ohio.
J. BRADFORD SARGENT, 620 Atlantic Avenue, - Boston, Mass.
ARBUCKLE, RYAN & CO., - - - - - - Toledo, Ohio.
FREDERICK E. BRUCE, 32 Lake Street, - Cleveland, Ohio.
SIOUX CITY ENGINE WORKS, - - - Sioux City, Ia.
ATLAS IRON WORKS, - - - - - San Francisco, Cal.
A. L. CROCKER, 27 South 4th Street, - - Minneapolis, Minn.
S. K. GREGG, 612 Pullman Building, - - - Chicago, Ill.
HUGHES & RIGBY, Bank Baltimore Building, - Baltimore, Md.
HAGAN & AUSTIN, Odd Fellows Building, - - St. Louis, Mo.

ALFRED CREBBIN, 1310 18th Street. - DENVER, COLO.

THAYER & JACKSON STATIONERY CO., CHICAGO.

# "THE STIRLING"

## WATER TUBE HIGH PRESSURE BOILER.

*Scientifically and Mechanically Correct.*

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IN presenting our system of water tube safety boilers for your consideration, we shall endeavor to do so as briefly as possible, confining ourselves simply to a description of its working merits and advantages, as compared with other boilers, and the results attained.

The merits of the water tube system, as compared with the two-flue and return tubular boilers, are conceded by the best engineering authorities, so that our chief endeavor is to substantiate our claim that we make the *Best Water Tube Boiler.* In doing this we in no manner wish to detract from the merits of other systems which we fully recognize, and in fact, have fully taken into consideration in designing and perfecting our own.

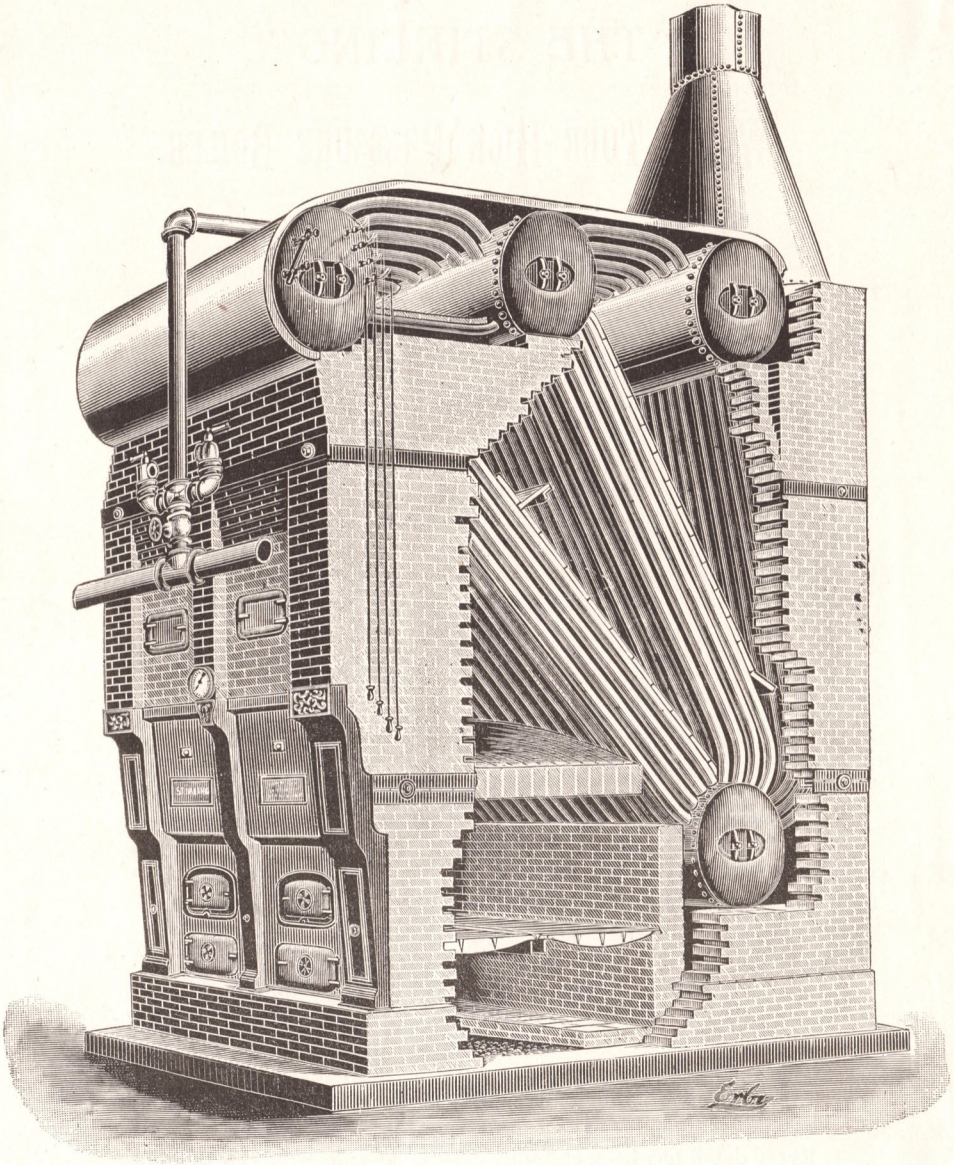
"THE STIRLING" is simply the latest scientific and mechanical evolution of all preceding research, experiment and result, added to years of careful study and individual experience. The aim has been to simplify and strengthen, to render safe and more effective, and at the same time to cheapen first cost and secure the greatest possible economy in labor and fuel. This was by no means an easy task, yet we believe we have accomplished it, and are fully satisfied to leave the verdict to any experienced engineer, architect or other competent authority after fair and impartial investigation.

Years ago a few prominent engineers predicted the present imperative demand for a *Safe High Pressure Boiler.*

The increase in demand led to numerous attempts to obtain this high pressure, resulting in a rapid increase of disastrous explosions, showing conclusively the necessity for marked improvement in scientific conception and mechanical construction.

This condition of affairs encouraged the effort that produced "THE STIRLING," which is not only safe at high pressure, but has also the other essential features of an *Ideal Boiler.*

Every detail has been carefully calculated and tested thoroughly by educated and practical men.



It is simple in construction, yet the studied and scientific arrangement of all its parts insures *Safety, Economy, Efficiency and Durability.*

The essential qualifications of a perfect boiler are generally recognized and understood; the difficulty has been to reconcile theory with practice and realize the known qualifications.

In claiming these qualities for "THE STIRLING" as the *Ideal Boiler*, we expect and are prepared to meet with refutation and counter claims and to *prove the correctness of our assertions.*

All we ask you to do is to follow carefully each claim set forth, and weigh impartially each scientific and practical advantage as *compared with other Boilers* of any type whatever.

# COMPARATIVE ADVANTAGES

—OF—

# "THE STIRLING."

## Simplicity of Construction.

This is a matter of primary importance, being elementary to cheapness, economy, safety and a number of other necessary qualities of a *Perfect Boiler.*

"THE STIRLING" consists simply of two or more upper wrought steel drums connected with each other and with a lower or mud drum, also of steel, by tubes expanded directly into the drums.

This comprises the whole boiler, *not an ounce of Cast Iron or Cast Steel* being used in its construction. The importance and value of this latter quality will be readily recognized and promptly conceded by all competent authorities.

To fully appreciate its value, it is but necessary to remember that, from the earliest inception of the more advanced theories of boiler making, it has been the constant endeavor of the thinking inventor and manufacturer to *eliminate Cast Metal from the Construction of Steel Boilers.*

This has never been fully accomplished until the advent of "THE STIRLING," which in this respect, as others, marks a new era in the improved generation of steam.

## High Pressure Steam.

The demand for high pressure steam in connection with modern engines is increasing rapidly, and "THE STIRLING" we believe stands at the head of all other boilers for especially this class of work, at moderate prices. Our boilers are all subjected to a cold water test of 200 lbs. and are guaranteed for a working pressure of 150 lbs. with economy and safety. The value of this feature will be appreciated by engineers and steam users.

## Conductivity.

The advantage of a thin heating surface over the thick plates used in ordinary boilers, must be apparent to all steam users of even limited experience, upon the most casual examination.

In the horizontal tubular boilers, the comparatively thick shell hinders the transmission of heat, and, being directly over the fire, tends to burn and blister as the accumulation of sediment and scale increases. Result, life and efficiency of plate destroyed, and possible disaster.

The thin tube surface, on the other hand, so assists the transmission of heat that the most intense fire cannot injure the surface, while the tube is covered by water on the inside. This is true in a measure of all water tube boilers, but especially true of "THE STIRLING," by reason of its construction.

## Fire Contact With Riveted Joints.

Riveted joints are concededly the weakest parts of the ordinary boiler's structure and consequently least adapted to stand the unequal expansion resulting from the various strains produced by fire contact. This serious difficulty and objection is wholly done away with in "THE STIRLING."

## Wide Grate Surface.

Owing to its construction our boiler will admit of a much *Wider Grate Surface* than any other, thus giving to each tube its full quota of *Direct Heat Contact*, which cannot be the case where the requisite capacity in grate surface is obtained by a long narrow fire box.

The advantage of this will be readily perceived.

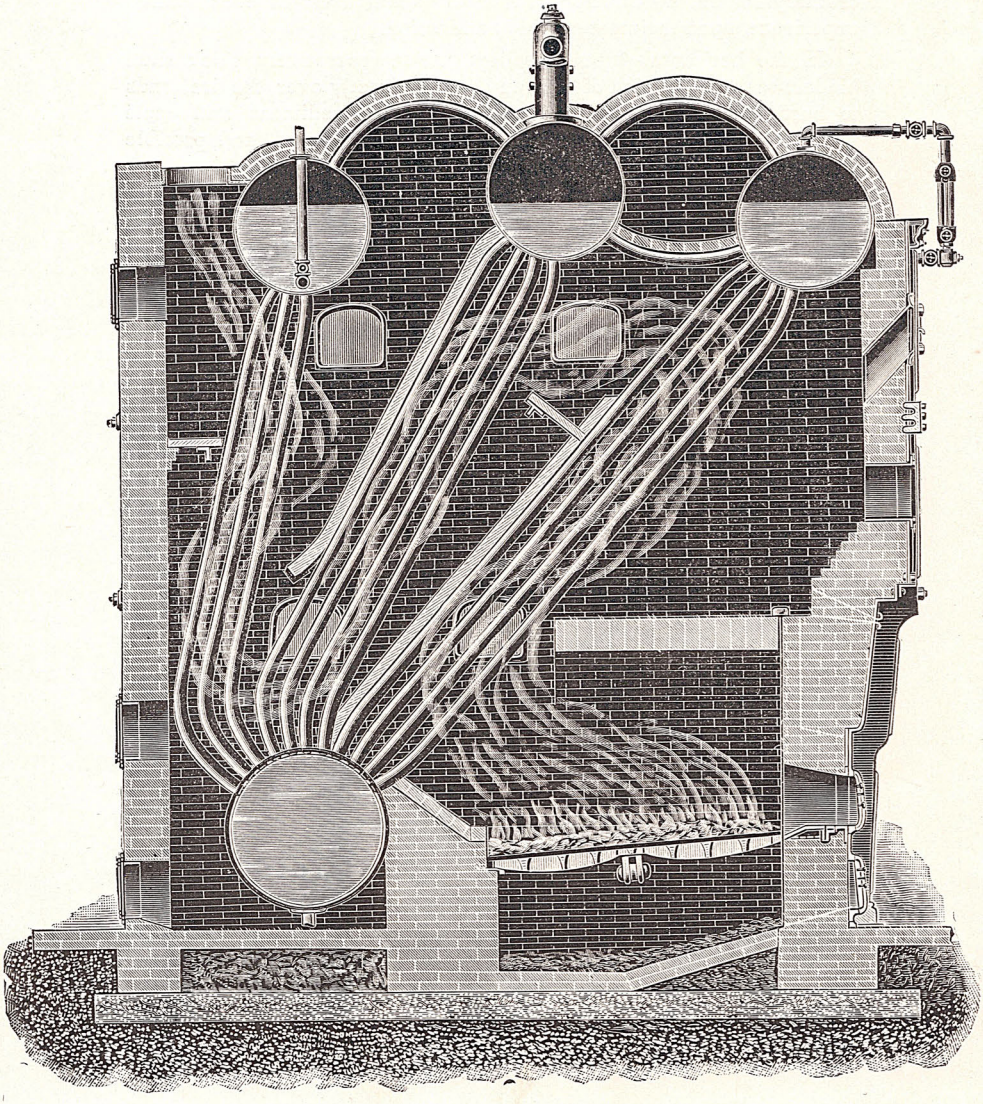
## Superior Draft.

Upon examination it will be seen that "THE STIRLING" has a *Large Draught Area*, resulting from wide grate surface and large tube chambers.

The nearly vertical position of the tubes, and the arrangement of the brick baffle plates in the large tube chambers, insure *good Draught* at all times.

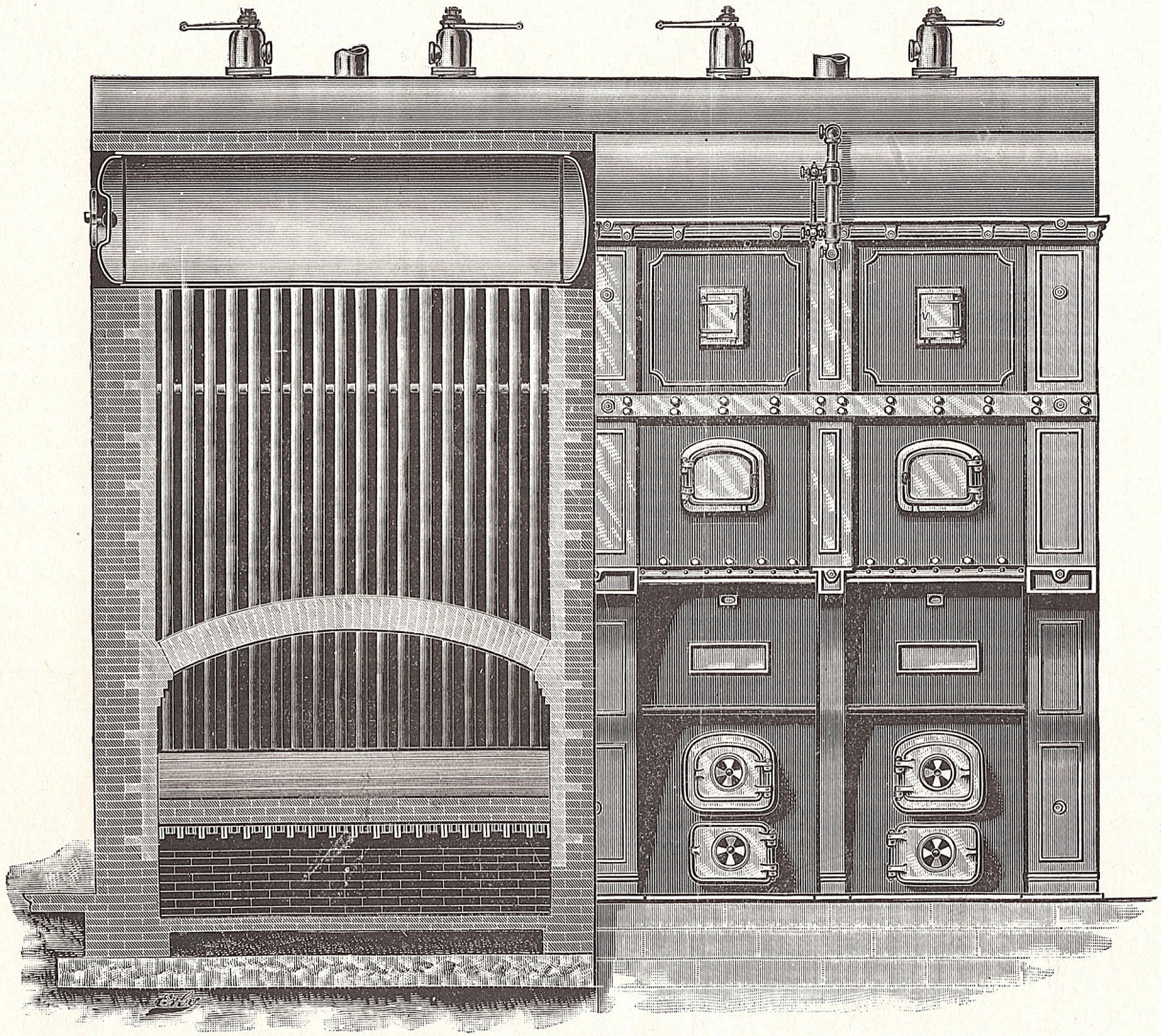
## Perfect Combustion.

The wide grate surface and good draught area, combined with the incandescent *Fire Brick Arch* over the furnace, admit of and insure a thorough mingling of the gas and air, and effect more complete and perfect combustion than in any other system.



# 250 H. P. STIRLING BOILER.

SECTIONAL VIEW.



Front Elevation of two 150 H P. Stirling Boilers in One Battery.

## Thorough Circulation.

The importance and necessity of this quality in efficient steam generation is fully recognized.

Forced or imperfect circulation causes "foaming," producing *Wet Steam* and consequent working irregularity of both boiler and engine.

The circulation of "THE STIRLING" is steady and thorough, not intermittent or violent, as is the case where insufficient tube area connects the water tubes with the water or circulation drums.

Even the best types of water tube boilers have a water outlet or *Connecting Tube Area* of but 10 *to* 15 *per cent. of the Water Tube Area. Can a Perfect Circulation be secured under such conditions?*

"THE STIRLING" *supplies a separate outlet for each Water Tube equal to its own area.* In other words, *each tube* is expanded directly into the circulating drums, and *furnishes its own outlet,* giving 100 *per cent.* of outlet as compared with 10 *to* 15 *per cent.* in other types.

This is not assertion but fact.

Please realize and compare this difference when estimating the various claims for *Perfect Circulation* and appreciate its importance.

This perfect circulation insures

## Dry Steam

Requiring no superheating or "drying."

Every engineer appreciates the necessity for dry steam, and the advantage of every boiler being *its own Superheater,* or, in other words, furnishing its own *Dry Steam* without assistance.

## Getting up Steam Quickly.

The advantage of the water tube over the return tubular type of boilers, in developing "quick steam," has been thoroughly tested and demonstrated.

The numerous divisions of the water currents, and the thin tube heating surface, very greatly assist rapid yet efficient steam raising.

This point has been carefully considered and provided for also in the general mechanical construction and arrangement of "THE STIRLING," which materially aid the advantages of the ordinary water tube boiler.

## Heat Absorption.

This is a most important factor of efficiency and economy. Every cubic inch of "live" gas which escapes through the chimney has failed to pay the toll a perfectly constructed boiler should exact, and is just so much fuel, labor and utility wasted. This has been carefully considered in "THE STIRLING" in the general construction and especially in the tube arrangement, being nearly vertical at an angle, which experiment

has proved to be the most advantageous for the production of steam. The tubes are passed and enveloped by the gas currents in such a manner as to utilize all their heat energy.

## Expansion and Contraction.

The tubes in "THE STIRLING" are divided into sets.

Each set is expanded into a separate drum.

This allows for unequal *Expansion and Contraction* in its general parts, and the bends in the tubes provide for any unequal expansion in the individual tubes.

This, as a material element of safety, will be readily recognized. The thorough circulation of "THE STIRLING," heretofore explained, materially diminishes and prevents the usual strains of unequal expansion.

## Labor in Cleaning.

This is a very important factor of economy in operation.

Steam users will understand the difficulty, labor and consequent expense of "boiler" or "cleaning day" in a large plant.

This is a regular and frequent occurrence in all districts where muddy or impure water prevails, as, for example, the "Wheeling," W. V., district, where the water is very muddy, and the Tiffin, O., district, where artesian well water, strongly impregnated with lime and magnesia, is largely used.

"THE STIRLING" *Boiler is practically Self-Cleaning.*

The nearly vertical position of the tubes naturally precipitates all sediment into the comparatively *Cool Mud Drum* below, from which it can be readily and frequently blown out.

The water being fed into the third or rear upper drum, as shown in the cut, has to pass through 60 to 70 tubes, 14 ft. long, in passing to the mud drum below.

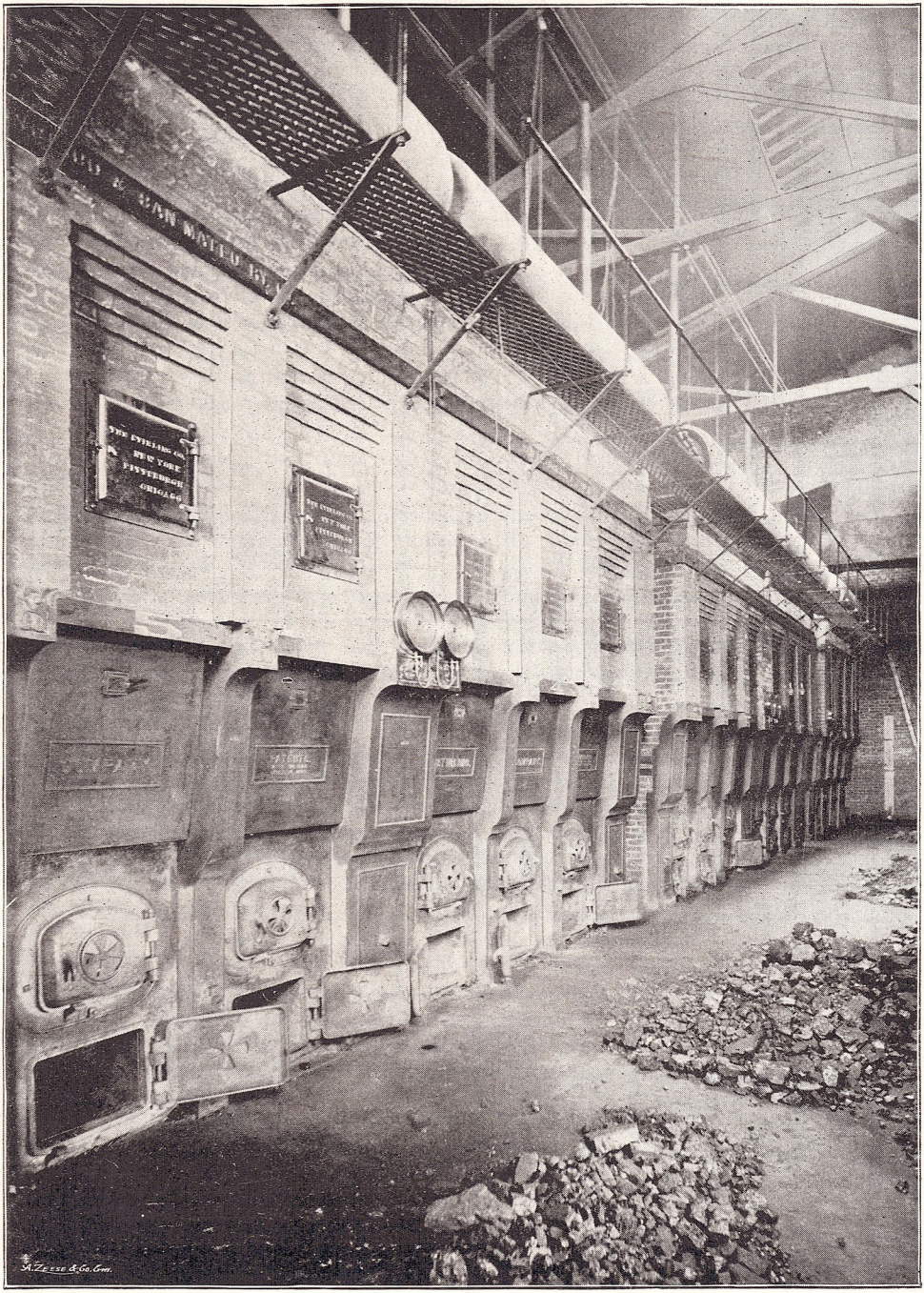
Coming in contact with the heated gas currents ascending, it parts with all chemically impure and scale-bearing matter, together with all the solid matter or sediment originally contained in it, which are naturally precipitated down these back tubes and into the mud drum, where it is blown off.

This insures practically *Chemically Pure Water* in the first and second bank of tubes.

Plants of "THE STIRLING" boilers are in active operation, which have rendered the highest possible service *without having been cleaned for six months.* This is not an isolated case but one of several.

## Accessibility.

While "THE STIRLING" is practically *Self-Cleaning*, for reasons above stated, we appreciate the necessity for an occasional looking into and general overhauling.




1250 H. P. STIRLING BOILERS AT THE POWER HOUSE OF THE SAN FRANCISCO & SAN MATEO RY. CO.

Let us compare the labor required to do this with that required by other boilers.

*By opening one man-hole in each drum access is gained to every part of the interior of the steel plates and to both ends and the interior of every tube.*

The exterior also of plates and tubes is accessible at all points.

No stays or tubes in the way as in the horizontal tubulars, or numerous joints to be adjusted as in other water tube boilers.

*For cleaning the interior of the tubes*, a scraper is provided made of two pieces of thin sheet steel the exact size of the inside diameter, and joined together some three inches apart, with a flexible steel chain, attached to both sides.

Two men, one in the lower and one in the upper drums, can do all the necessary cleaning, and have everything replaced and in readiness for steam raising in a very short time.

After cleaning, *only* the *Four Steam-Tight Joints* of the four manhole plates to be made and the *Entire Work is Completed.*

In any other type of water tube boilers, between *Two and Three Hundred Steam-Tight Joints* to be made. What does this difference mean?

It means serious loss of time and service of boilers, and consequent loss of money. This is no inconsiderable item. The matter of accessibility, too, is of great importance when making

## Repairs.

We have already endeavored to show the absence of all liability to break, burn or otherwise injure "THE STIRLING" as a whole, or any of its individual parts. There is practically nothing to injure or get out of order. Nothing enters into its construction but wrought steel plates and tubes of the best possible material. Four steam-tight joints to watch or adjust—not two or three hundred, with a like number of cast manhole plates and rubber gaskets to break and get out of order.

But should any break occur in any of the tubes through accident or carelessness, another can be substituted in a very short time.

To remove the manhole plate in the mud drum and in the upper drum attached to the affected tube, cut the expanded tube end inside the drum, remove and replace the tube and manhole plate, is the work of but a few minutes. *The replacing of a single Tube* in any other water tube boiler not only requires a much longer time, but in many cases *the sacrifice of an entire section of tubes.*

## Cubical Capacity.

Proportionate water and steam capacity is an essential point in efficient steam production. It is one that has been carefully considered and utilized in "THE STIRLING," as close examination will develop and substantiate.

## Economy.

We have endeavored to show briefly the various qualities we not only claim, but know our boiler to possess. If these qualities exist, and they do, they are their own best evidence and surety of economical operation.

We give better draught, circulation and combustion. We absorb more heat and lose less in escaping gases; lose little or none from dust on the outside, or sedimentary and chemical deposits on the inside of tubes, and consequently *use less Fuel; use any kind of Fuel* and *any kind of water* with the best results; steam quickly and furnish *Dry Steam;* give more steam and power for less heating surface and fuel, and lose no time, labor or material in cleaning or repairs.

Is this *an economical boiler to use?*

## Safety.

The best possible *Boiler Insurance* is an *Absolutely Safe Boiler.*

This is a point that has never received sufficient and proper consideration.

*Cheap Boilers* are in many instances the first consideration, as we know by experience.

The question of economical operation is frequently overlooked and *Safety* absolutely ignored or *taken for granted.*

Is this true economy?

Let us consider a moment.

In event of explosion what occurs?

No matter how fair and equitable the insurance company, the property loss and other damages are difficult of adjustment.

New buildings, new boilers and new machinery to be replaced, and death or accident damages to be adjusted. Loss of time and loss of business, which the insurance does not cover. Numerous accidents occur each day where men are killed or disabled, but the idea of *responsibility* is hurriedly passed over and evaded.

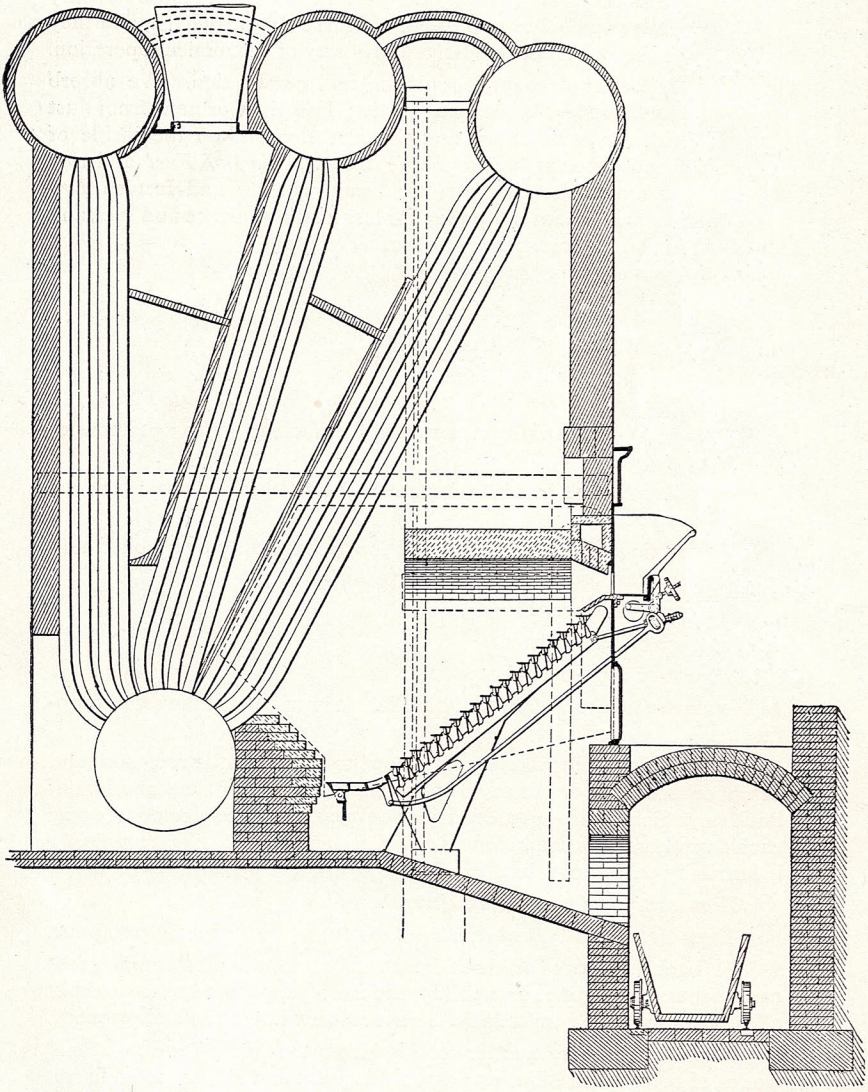
*We remove all danger of disastrous explosions.*

"THE STIRLING" *Boiler will not explode under any circumstances.*

We have had two or three instances occur, where through gross carelessness, negligence or inability, the use of any other boiler would in all probability have resulted in the serious loss of both life and property.

We print elsewhere a letter received from the Ætna Iron and Steel works, of Bridgeport, Ohio, bearing on this point and fully substantiating our claim.

If from carelessness, there should be a heavy fire in the furnace, and the water low, the worst that could happen would be the rupture of the front tubes. This would relieve the pressure immediately without serious injury or disaster.



## STIRLING BOILERS.

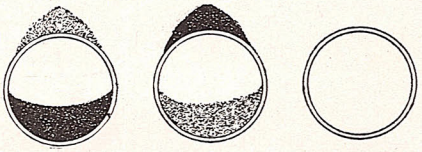
EQUIPPED WITH MECHANICAL STOKERS AND ASH PITS,

**1065 H. P.**

NATIONAL SEWER PIPE CO., BARBERTON, O.

OBSTRUCTION OF TUBES: In the horizontal tubular and the other water tube boilers, the gases pass through the tubes covered with deposits of scales or soot, resulting in the passage of heat being obstructed and draught poor.

The three small cuts below will illustrate this correctly.



Return Tubular. Ordinary Water Tube. Stirling Water Tube.

In "THE STIRLING" the above objectionable features have been overcome.

It will be noticed that the "Return Tubular" tube shows large deposits of soot on the inside and scale on the outside, while the ordinary water tube reverses this.

"THE STIRLING" shows a *clean inner and outer surface*. The reasons for this have been previously explained in this pamphlet.

STRENGTH: The drums are made entirely of "Best Flange" steel, and tubes of best charcoal iron or soft, low carbon steel. Both materials are carefully inspected and tested, both at the mills and shops.

As we have before stated, *no cast metal* of any kind is employed. The value of this has been dwelt upon under another head, but is repeated here as a *most important factor of safety*.

WORKMANSHIP: Unlike a number of the other makers of water tube boilers, *we have our own shops*, containing the latest and most improved tools and machinery, as mentioned on introductory page.

This enables us to personally superintend each detail of manufacture, and test to our full satisfaction each piece of material used.

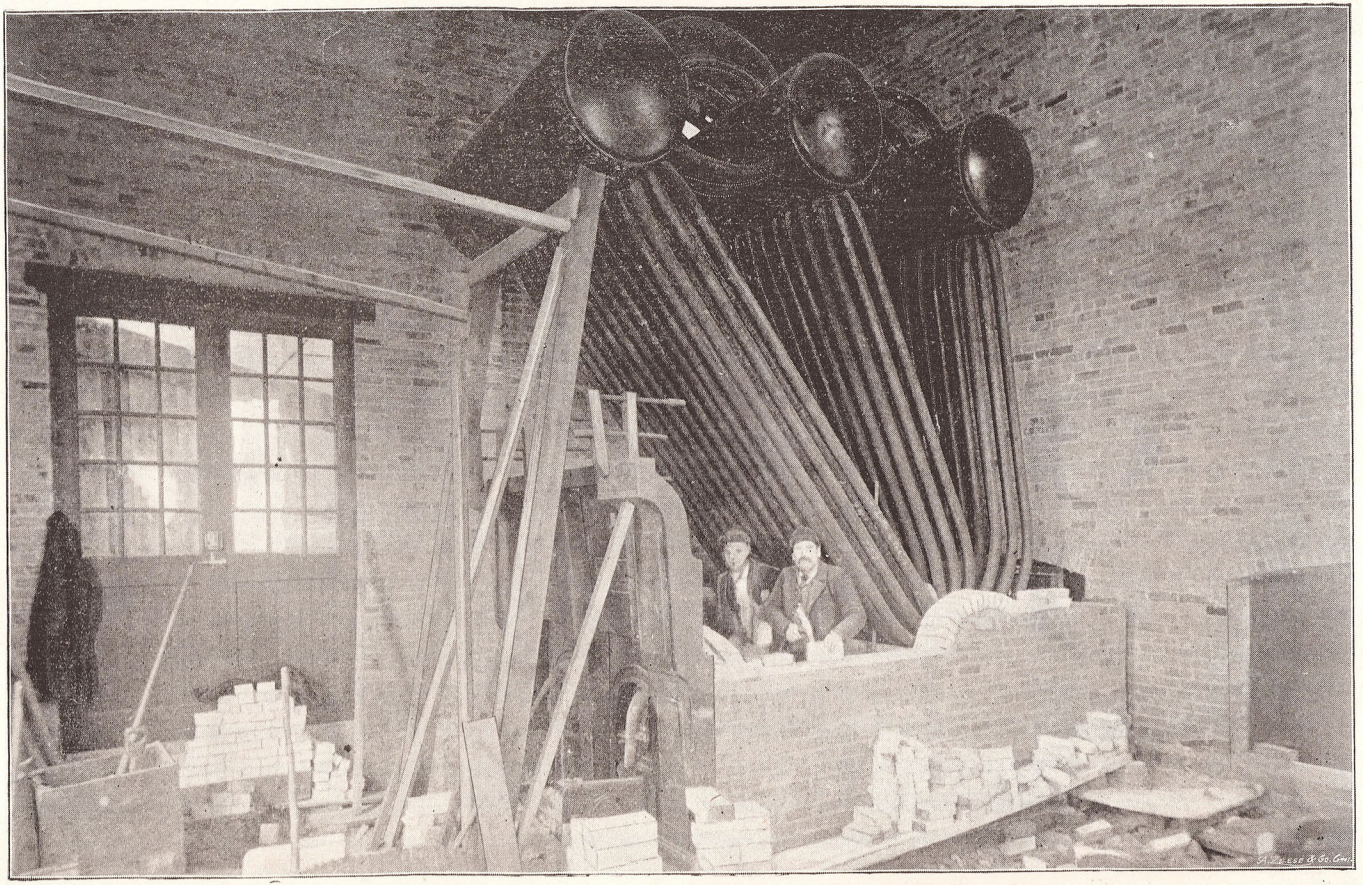
Our Superintendent has had some twenty years experience in expert boiler making and setting, and steam generation, and is personally interested as a stockholder in our Company in the *high class of work* sent out.

These are incontrovertable reasons why "THE STIRLING" is *an absolutely safe Boiler*, and is *its own best insurance* against loss of life and property.

Can you accept the responsibility of the one or afford the other.

## Economy of Space.

"THE STIRLING" occupies less ground space than any other boiler, and consequently a smaller boiler room and house.



100 H. P. BOILER IN COURSE OF ERECTION AT FACTORY OF M. C. BULLOCK MFG. CO., CHICAGO.

This is not only a definite saving in cost of foundations, building and ground, but admits of location in limited space where other boilers could not be erected.

## Transportation.

The shipping weights of our boilers are from one half to two thirds less than that of other makes. This means a considerable reduction in freight which is a very important item to many steam users.

These facts, with the simple construction of "THE STIRLING" boiler, together with our new and unequaled facilities for good workmanship and economy in manufacture, enable us to offer you the *safest, most economical, satisfactory* and *best boiler* in the market at *a satisfactory price.*

## Which Will You Buy?

We have endeavored to show you thus briefly why we claim our boiler to be *the best* and to possess all the essential qualifications and requirements of the *ideal boiler.*

We do not say that at some future time it may not be improved upon. Indeed, we ourselves shall use all effort to this end, if it be possible. This is an age of research, experiment, improvement and progress.

What we do claim—and justly—is this: that "THE STIRLING" boiler embodies all the absolutely essential features now required and demanded by engineers and steam users. We might embody in this pamphlet records of various evaporative and other tests, all remarkable in results obtained, but we are now engaged in making a series of such tests, results of which will be furnished you on application.

The practical working record of our boilers wherever used—in rolling mills, blast furnaces, electric power houses and manufacturing plants in general, and some of the largest buildings throughout the country—is the best proof of its superiority, and of the justice and the value of our claims.

If then, "THE STIRLING" is superior to all others, and it is; if it will reduce expenses largely, and it will; if it removes all danger to life and property, and it does; certainly your interests will be very materially enhanced and profits increased by its adoption.

*Can you afford to buy any other?*

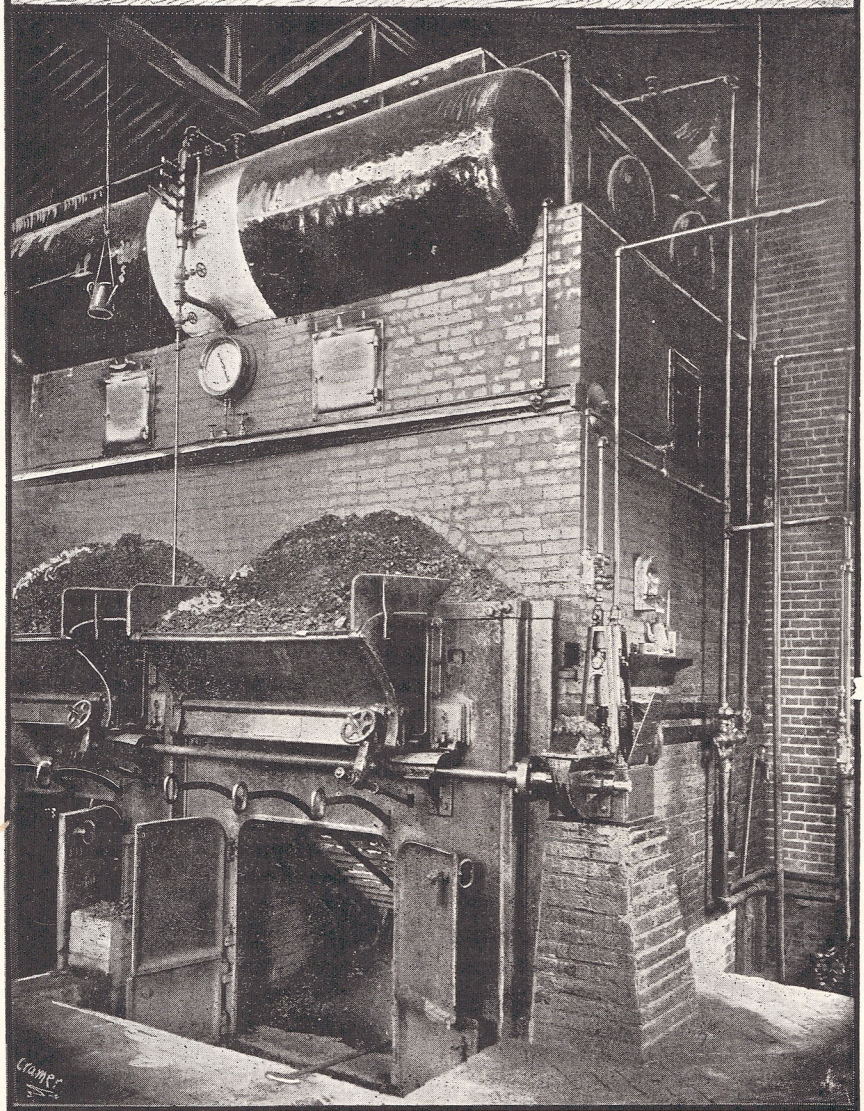
If you are interested in steam generation, if you are now, or will be later in the market for boilers, your personal investigation and examination is solicited.

Where this is impracticable, more complete information and detail will be sent on application, and if desired, our representatives will see you personally and name prices which, we believe, will be satisfactory.

Very truly,

THE STIRLING COMPANY.

# THE STIRLING COMPANY.



## WATER TUBE SAFETY BOILERS

AS THEY APPEAR AT

THE GOODRICH RUBBER FACTORY, AKRON, OHIO. U.S.A.

# TESTIMONIALS.

Although comparatively new, our boilers have, in open competition with all the leading water tube and other types of boilers, been awarded the preference by some of the largest firms throughout the country, after the most careful and thorough investigation.

A number of these plants have been running for long periods and have fully demonstrated their superiority, and we can refer you to all classes of steam users.

We give you below a few testimonials selected from a number received:

ALLEGHENY, PA., February 24, 1891.

*Messrs. Arbuckle, Ryan & Co.,*
*Toledo, Ohio.*

GENTLEMEN:—Yours of date 20th inst. was duly received and contents noted in regard to The Stirling Water Tube Boiler. We are well pleased with The Stirling Water Tube Safety Boiler. They are very economical over the double-flued boilers we had in use. They work well with the water we use from the Allegheny river. I have run them 70 days without cleaning, opened them up and found only about one quart of light scale in the bottom of each boiler, and the tubes and shell of bottom drum perfectly clean. During 70 days' run with the five double-flued boilers, there would have been three bushels of strong scale and dirt. In general, I like the boiler. It is the simplest and easiest boiler I ever handled, and the more I handle it the better I like it. We have 250 H. P. in two batteries, 125 H. P. each. I consider it safe, economical and easily managed.

I am, yours respectfully,
J. C. ANDERSON,
*Engineer in Charge Eagle Power Co.*

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ENGINEER'S DEPARTMENT,
PRESBYTERIAN HOSPITAL,
70th St. and Madison Avenue.
NEW YORK, February 24, 1891.

*Messrs. Arbuckle, Ryan & Co.,*
*Toledo, Ohio.*

GENTLEMEN:—Your favor of the 20th inst. is before me. Replying, I am pleased to say that the Stirling Boilers are giving the best of satis-

faction. I have four boilers of one hundred and fifty horse power each, making 600 horse power, and am working them under very adverse circumstances with 20 per cent. less fuel than would be used under a horizontal tubular boiler, working ordinarily. Their strong point is that they will use any kind of water, all sediment falling to the lower drum, which does not come in contact with the fire. I am well pleased with boilers in a general way, and shall recommend them to all steam users.

Respectfully yours,

H. G. WEST, *Chief Engineer.*

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PRESBYTERIAN HOSPITAL.

70th St. and Madison Ave.

NEW YORK. Feb. 13th, 1892.

*National Carbon Co.,*
*Cleveland, Ohio.*

GENTLEMEN:—Replying to your letter of the 11th inst., will say that the Stirling Boilers are quick steamers, economical in fuel, and the circulation is good. We have found no scale in them as yet, and have no trouble in keeping them clean, and have had no cause to expend anything on repairs. The evaporation is about 9½ pounds per pound. The boilers have been in use about three years.

Very Truly Yours,

C. IRVING FISHER, M. D., *Supt.*

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OFFICE OF

D. & J. JARDINE, ARCHITECTS,

1262 Broadway, Cor. 32d St.

NEW YORK, February 24, 1891.

*Messrs. Arbuckle, Ryan & Co.,*
*Toledo, Ohio.*

GENTLEMEN:—In reply to yours in reference to the Stirling Boilers, beg to say that we have put in four of them, two in an office building and two in a factory, and all for the same owners. They (the owners) were so well pleased with the boilers in the office building that they determined to use them again, and they and we are confident it is a wise step.

As to your queries, we answer:

1st. We believe the Stirling Boilers are more economical by at least 25 per cent. in coal than others.

2d. They are calculated by their design to use almost any kind of water, the circulation being so perfect, and the mud drum is the sure receptacle for all sediment.

3d. We have put in only about 250 horse power, but we should not hesitate to use them for all purposes and in the largest plants.

Yours truly,

D. & J. JARDINE.

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OHIO IRON COMPANY.

ZANESVILLE, O., March 26, 1891.

*C. G. Blake, Esq.,*
*Cincinnati, Ohio.*

DEAR SIR:—Your favor of the 3d inst,, has been referred to our Mr. F. C. Greene, manager of the Blast Furnace, where our new Stirling Boiler is located, and he asks me to say in response to your inquiry, that he had the boiler in use about five months before we stopped our furnace, and that it gave very good satisfaction; that it is a good steam maker and economical as well; and that he had no trouble whatever with it, and none whatever from "wet steam." Since blowing out he has made a thorough examination of the boiler and finds it much freer from lime, scale and sediment than any of his other old-fashioned batteries of boilers. In brief, we consider it a good kind of boiler.

Yours very truly,

OHIO IRON COMPANY,

M. CHURCHILL, *Pres't.*

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OFFICE OF

EDISON ELECTRIC ILLUMINATING CO.

ALTOONA, PA., March 25, 1891.

*The Stirling Co.,*
*Lewis Block, Pittsburgh, Pa.*

GENTLEMEN:—In answer to your inquiry of March 24th, we would say that we are more than pleased with the results from your boiler which we have in use. We find it very economical in the consumption of fuel, and also find very dry steam. We find your claims verified in being a self-cleaning boiler. On our old batteries we clean every two weeks, while in this boiler we found nothing in the mud drum after a run of six weeks, the tubes and drums being in the same condition as when the boiler was first started.

We think your method of feeding the water in the boiler in the coolest place, thereby bringing it up slowly to boiling temperature at the rear, obviates all trouble from scale.

We have no trouble to get more than the rated capacity of the boiler without forcing.

Yours respectfully,

E. B. GREENE, *Sup't.*

THE TIFFIN EDISON ELECTRIC ILLUMINATING CO.

TIFFIN, OHIO, Dec. 12, 1890.

*The Stirling Co.,*
*Water Tube Safety Boilers,*
*No. Courtlandt St., N. Y.*

DEAR SIR :—In reply to yours of recent date, we are pleased to say that the two Stirling Water Tube Boilers, (104 H. P. each) purchased last summer, are giving us entire satisfaction.

We have been using a Babcock and Wilcox boiler for over six years with most favorable results, and when we were in the market for an addition to our steam plant some of our directors believed it unwise to consider anything else than "the bridge which had carried us safely over." When the Stirling Boiler was brought to our attention, some of us, however, believed that it presented some advantages, mainly those of lower first cost and greater ease in cleaning.

We have now had them in use about three months, and the result exceeds our most sanguine expectations. We use well water which is strongly impregnated with lime and magnesia. When opening the boilers after a six weeks' run, we found the front and middle upper drums, together with the corresponding banks of tubes, as clean as the day we started. The back upper drum and the back tubes had some scale, but the same was so soft that it was easily washed out.

The bulk of the magnesia we found in the bottom of the lower or mud drum, where it had collected at the ends, that in the centre having passed out through the blow-off.

We use natural gas fuel at a fixed price per month, and have, therefore, made no test as to efficiency; but we are satisfied that the boilers are very economical and will produce steam far beyond their rated capacity.

Yours very respectfully,

THE TIFFIN EDISON ELEC. ILL. CO.

By J. F. BUNN, *President.*

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AETNA IRON AND STEEL COMPANY.

BRIDGEPORT, O., Feb. 24, 1891.

*Mr. Frank C. Roberts, C. E.,*
*Philadelphia, Pa.*

DEAR SIR :—Referring to your favor of recent date, we beg to advise that our reply has been delayed by reason of the press of other matters, and of the writer's absence. We have 800 H. P. of the Stirling Boilers in use, and have been for the past six months, running 600 H. P. constantly, night and day. We fire them with dirt slack, nut coal mixed. Our daily consumption of this fuel is about the same as we formerly used of screened lump coal for our two-flued boilers. We carry 120 lbs. pressure, and find the steam practically dry. We have had the very muddy waters of the Ohio River to contend with ever since the boilers were started, but we are gratified to be able to say that we have

had no occasion to clean the tubes, they, well as the shells, being substantially free from scale and mud, as much so as the day they were put in position.

Trusting this will give you all the desired information, I am

Very truly yours,

B. M. CALDWELL, *Manager.*

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NEW YORK, March 19, 1891.

*James Meily, Esq.,*
*Philadelphia, Pa.*

DEAR SIR:—In reply to yours of the 13th, regarding the boilers of the Stirling Company, we beg to say that we have had considerable experience with those made by this Company and with other types of boilers, and we do not hesitate to say that we shall use the Stirling Boilers where we can do so, for these reasons, viz:

1st. Their absolute safety.

2d. Their simplicity of construction and facility for examination.

3d. They are very enduring and very clean.

4th. Their economy in the matter of fuel is something phenomenal.

5th. They take comparatively little space, and are the best power boilers we know of, as they are quick and steady steamers.

6th. We believe they are now sold cheaper than other water tube boilers.

Yours truly,

D. & J. JARDINE,
*Architects, 1262 Broadway.*

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NEW YORK, March 19, 1891.

*James Meily, Esq.,*
*Philadelphia, Pa.*

DEAR SIR:—Yours of the 13th inst. inquiring about Stirling Boilers, is at hand. I put in two boilers of 150 H. P. each in the summer of 1889. They have worked to my entire satisfaction, and last fall I put in two more of the same size. I consider them equal to any in the market. We have no repairs whatever to make, and when opened lately they were found clean and in good shape. I am satisfied they are an economical boiler, or I should not have duplicated the order. Several plants in the neighborhood all give good reports.

Yours very truly,

J. M. ROBINSON,
*Chief Engineer, Mills Bldg., New York City.*

OFFICE OF

JOHN BENJAMIN, LEE & COMPANY,

19 Williams Street.

NEW YORK, February 24, 1891.

*Messrs. Arbuckle, Ryan & Co.,*

*Toledo, Ohio.*

GENTLEMEN.—In answer to your inquiry I beg to say that we have used the Stirling Boiler in our down-town building, and also in a factory up-town, with entire satisfaction. We find them economical and in every way satisfactory.

Very truly yours,

R. L. CUTTING.

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NEW YORK, January 14, 1891.

*James Meily, Esq.,*

*Philadelphia, Pa.*

DEAR SIR:—We beg to acknowledge receipt of your letter of the 13th, and in reply to the same would say that, we gave the matter careful consideration before selecting the boilers in question, and that they, in our opinion, besides taking up less room and being easier to clean, are readily gotten at for repairs. We have seen them (300 H. P.) in active operation for about a year and a half at the Presbyterian Hospital, and a smaller one this winter in an office building, and have heard no complaint. In fact they have given such complete satisfaction that the Hospital people have duplicated their plant (now some 600 H. P.), and we are giving them (The Stirling Co.), more orders constantly.

Yours very truly,

J. C. CADY & CO.,

*Architects, New York City.*

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HAVEMYERS & ELDER SUGAR REFINING CO.,

117 Wall Street,

NEW YORK, February 24, 1891.

*Messrs. Arbuckle, Ryan & Co.,*

*Toledo, Ohio.*

GENTLEMEN:—Your letter inquiring about the Stirling Water Tube Safety Boiler is at hand. I know it to be much more economical than return tubular boilers. I have opened my boiler (February 22) for examination after six months hard work. I was surprised to find the inside of tubes and drums as clean as when new, no scale adhering to any part of boiler. All scale and sediment was in the lower drum. I am well satisfied with the Stirling Boiler, and have no hesitation in recommending the above boiler as the most economical and best steam boiler for stationary work that I have ever had charge of in my practice of over 25 years. Will be pleased to give any further information from time to time. I remain, gentlemen,

Yours respectfully,

JOHN H. MOORE, *Engineer.*

*The Stirling Company,*
*Pullman Building,*
*Chicago, Ill.*

WAUSEON, OHIO, Feb. 25, 1891.

GENTLEMEN:—In regard to the Stirling Boiler, would say that the reason we put in this boiler was because of the claim that bad water would not affect it like the common style; and after a six months' test, we find it to be true. We cleaned our old-style boiler every week, while we run this six weeks, and then find no scale where the flues come in contact with the fire. We now have no trouble to make steam, and our output has been increased.

Yours very respectfully,
LYON, CLEMENT & GREENLEAF.

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TIFFIN, OHIO, FEB. 21, 1891.

*The Stirling Company,*
*Pullman Building,*
*Chicago, Ill.*

GENTLEMEN:—Your letter of inquiry of the 19th inst., duly received, and in reply will say we have now had the Stirling Boilers in use about five months, and are very much pleased with them in every way. They are very economical in the use of fuel, admit of crowding far beyond their rated capacity; are very convenient in cleaning, and, above all, we find very little cleaning necessary. The separating of the lime, magnesia and other impurities, practically all takes place in the mud drum, and back upper drum, and thus avoiding scale in the tubes exposed to maximum heat. We will be pleased to give full information and every opportunity for investigation to any intending purchasers you may send here.

Yours very respectfully,
J. F. BUNN,
*Pres't. Edison Elec. Ill. Co.*

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AETNA IRON AND STEEL CO.

BRIDGEPORT, O., Jan. 5, 1891.

*The Stirling Company,*
*Water Tube Safety Boilers,*
*No. 74 Courtlandt St., N. Y.*

DEAR SIR:—Since writing you on the 23d ult., we have had the misfortune, through gross carelessness on the part of one of our engineers, to burn all the tubes and melt all the tile in our No. 3 boiler, owing to lack of water in the same. Fortunately, however, we are unable, to discover any serious damage to the boiler shells, and we have ordered from Jas. P. Withrow, for our account, tubes to replace the burnt ones. The only satisfaction that we can derive from this misfortune is that it demonstrates conclusively that the Stirling Boilers cannot be exploded from low water.

Respectfully,
AETNA IRON AND STEEL CO.

BRIDGEPORT, OHIO, July 26th, 1892.

*Messrs. Jeffrey Manufacturing Co.,*
*Chicago, Ill.*

GENTLEMEN:—Your favor of the 21st, received. The Stirling Boilers which we have in use are giving us good satisfaction. We use nothing else in our works but this type of boiler.

Respectfully,
AETNA IRON AND STEEL CO.,
JOHN A. TOPPING, *Sec'y and Treas.*

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WARREN, OHIO, April 29th, 1892.

*Morrison & Cass Paper Co,,*
*Tyrone, Pa.*

GENTLEMEN:—Your favor of the 27th, received, replying will say to you that we have recently had a terrible experience with our steam boilers in the shape of a disastrous explosion, which caused the death of three persons, and injuring many others, besides wrecking our plant, causing a stoppage of work, a loss of business, besides the extreme vexation and worry incident to such accidents.

The writer has had over forty years experience with steam generators and felt perfectly secure and safe from any trouble arising from that quarter. In addition to our own carefulness and close inspection, we had the inspection of the Hartford Boiler Insurance Company's men, which was made but three weeks before the accident. It is, however, a matter of consolation to us to know that out of the three hundred employes on duty that night, so few were hurt, and so many were spared right where the debris was thickest. The smoke-box, doors, fire fronts, etc., were found to have fallen right where twenty-five persons were at work.

The boiler that exploded was in a battery of four, each having its own water column and steam guage, and separate feed. The boilers were of the very best material, of 100 H. P. each, and well stayed, and of the return tubular type 66" shell, by 16 long, having fifty-six 4" tubes. Our mill was running right along, there was nothing unusual going on and everything apparently all right, when all at once the boiler exploded. Experts have examined the boiler but no one has given a cause for the accident. The three boilers that did not explode are in good shape; they are for sale cheap, as we have replaced them with 400 H. P. Stirling Boilers, with Roney stokers, making 600 H. P. in all.

At the time of the explosion our Stirling boiler was in use located close, and in a line with the battery of the four tubulars. It remained in place, but the fireman was blown forty feet away and was picked up insensible but not much injured. He is at work again.

The Stirling Boiler has to my mind, the following advantages:—It is safe and is an economical steam maker; it has no joints to leak; it is well made, and the circulation is so good that the tubes do not clog up. I consider it the safest and best boiler made. The fact that we laid aside three good boilers and put in the Stirling Boilers in their place, will demonstrate to you our faith in them better than words can.

Yours Truly,

THE PAIGE TUBE COMPANY

T. J. BRAY, *Sup't.*

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WARREN, OHIO, July 21st, 1892.

*H. S. Pell, Esq.,*

*Sup't The Stirling Company,*

*Barberton, Ohio.*

DEAR SIR:—I have just completed my figuring as to the economy of our Stirling Boiler Plant as compared with return tubulars in use previous to putting in the Stirlings. With the former we used a run of Mine coal, with our present plant we use slack, and we find that we do the same work at a saving of $16.25 per day, double term, and add to this one fireman less each turn, or two per double turn $4.00, making a total of $20.25 per day saved by the use of your boilers and stokers. A great many boiler men talk glibly about the saving of fuel, etc., the above is actual as shown by our books and records kept, of fuel consumption and labor. With kind regard, I am,

Yours Truly,

THOS. J. BRAY, *Supt.*

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OFFICE OF

THE TOLEDO BOLT AND NUT COMPANY.

TOLEDO, OHIO, February 15th, 1892.

*National Carbon Co.,*

*Cleveland, Ohio.*

Answering your inquiry of the 11th, regarding the Stirling Boilers, would say that our experience with this boiler has been of the most satisfactory character. It fulfills in every particular all the claims made by the manufacturers. We have had ours in use over a year and during that time we have not found it necessary to clean the tubes, no deposit of any kind showing on the frequent inspections that we have made.

We contemplate adding some new boilers to our Indiana plant, and will put in Stirling Boilers in preference to anything.

Yours Very Truly,

TOLEDO NUT AND BOLT COMPANY

GEO. O. CROMWELL, *Manager.*

OFFICE OF

THE BRADDOCK WIRE COMPANY.

PITTSBURG, PA., February 13th, 1892.

*National Carbon Co.,*

*Cleveland, Ohio.*

GENTLEMEN:—Replying to your letter Feb. 11th, we are pleased to state that our experience with the Stirling Boilers up to this time have been perfectly satisfactory.

We have had them in operation about six months, and have placed our second order for our Western plant.

Yours Truly,

BRADDOCK WIRE COMPANY.

E. R. POOL, *Ass't. Treasurer.*

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OFFICE OF

ABRAHAM S. PATTERSON.

330 Walnut Street.

PHILADELPHIA, Nov. 3rd, 1891.

*S. F. Nartrauft, Sup't.*

*River Furnace (Pickands, Mather & Co.),*

*Cleveland, Ohio.*

DEAR SIR:—Your favor of Oct. 31st, is received and I beg to say that we have in use Stirling Boilers at our furnace. They work with entire satisfaction in every respect and are wonderful steamers. If we put in increased boiler capacity, will probably put in this make. Never knew anything to work better.

Very Truly Yours,

MONTGOMERY IRON CO.

ABRAM. S. PATTERSON, *President.*

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GRAND RAPIDS, MICH., July 23, 1892.

*American Hoist and Derrick Co.,*

*Chicago, Ill.*

GENTLEMEN:—Replying to yours of 21st, inst, would say that the Stirling Boilers installed by this company last December are giving entire satisfaction. We have used no other water tube boilers before, but these are meeting our expectations fully.

Yours Truly,

EDISON LIGHT CO., of Grand Rapids.

THOS. F. BECHTEL, *Sec'y.*

DEADWOOD & DELEWARE SMELTING AND REFINING CO.

DEADWOOD, SOUTH DAKOTA, May 14th, 1892.

*The Stirling Company,*

*Pullman Bld'g, Chicago, Ill.*

GENTLEMEN:—In reply to your questions of the 10th, the boiler is doing well; it makes steam and plenty of it and is economical in fuel. We have opened it twice during the past year for cleaning and found it in good condition both times. Owing to the fact that the water in your boiler passes through the tubes, instead of the fire passing through the tubes as in the ordinary style I am enabled to use a coal like that from New Castle, Wyoming, that my neighbors with ordinary boilers find very trying owing to the clogging up of their tubes with heavy smoke.

Yours Truly,

DEADWOOD & DELAWARE SMELTING AND REFINING CO.

FRANKLIN B. CARPENTER, *Sup't.*

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HAMILTON, OHIO, April 16th, 1892.

*The Jeffrey Manufacturing Co.,*

*4 South Canal Street,*

*Chicago, Ill.*

GENTLEMEN:—We have your favor of the 15th, inst., in regard to the Stirling type of water tube boilers and asking our opinion of those we have in use.

We have 300 H. P. of the Stirling type, and about the same number of the Babcock & Wilcox. We have found the Stirling the cheaper of the two as to first cost. We think they are constructed on a thoroughly scientific principle, have a first class circulation and will continue to prove entirely satisfactory to us.

We are impressed with the safety quality of the water tube boiler over the ordinary tubular or flue boilers in the matter of explosions. If you will look over the "Cassier's Magazine" for January, you will observe an article written by Mr. Allen, President of the Hartford Boiler Insurance Company, wherein there is a number of illustrations of the effects of explosions on boilers. I think you will fail to find any one of these illustrations having reference to water tube boilers, which to my mind cleans their skirts of the liability of disastrous accidents. This comparative immunity from accidents was a large factor in deciding us in favor of the water-tube type of boilers. Since their use we have ceased to insure our boilers altogether.

If you should send a member of your firm here, we would be very happy to see him and show him the boilers and give him any other information we possess.

Yours Truly,

NILES TOOL WORKS,

ALEX GORDON, *President.*

PITTSBURGH, PA., July 1, 1892.

*Jeffrey Manufacturing Co.,*
*Chicago, Ill.*

GENTLEMEN:—We are in receipt of your favor of the 4th inst., and note your inquiry regarding the Stirling Boilers. In reply we beg to say, we are using 600 H. P. of their boilers here and they are giving us entire satisfaction. They are good steamers and economical in the use of coal. So far we are perfectly satisfied with them, and would not change them for any other Boilers we have examined into.

Trusting this will be of advantage to you, we are,

Yours Truly,
MARSHALL KENNEDY MILLING CO.
F. J. WEIXEL, *Sec'y and Treas.*

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JAMESTOWN, N. Y., Oct. 8th, 1891.

*A. L. Cook, Esq.,*
*Minneapolis, Minn.*

DEAR SIR:—Your favor of the 6th, requesting our experience with the Stirling Boiler has just reached us. In reply would say that we started June 13, 1891 with two 150 H. P. boilers, expecting of course we would need them both to operate on three 150 H. P. compound condensing engines built by the Phoenix Iron Works, Meadville, Pa. (the engines running continually). We found it impossible to use them both without exhausting steam all the time. We shut one off and have been supplying the three engines with steam from one 150 H. P. Stirling boiler, and we are obliged to watch the steam very carefully or it will blow off at least half the time. They are certainly the greatest steamers. and the most economical boilers we know of. If your trade doubts this, we would advise them to come and investigate.

Yours Truly,
JAMESTOWN STREET R'Y CO.
G. E. MALTBY, *Supt.*

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NATIONAL SEWER PIPE COMPANY.

BARBARTON, OHIO, Aug. 1, 1892.

*The Jeffrey Manufacturing Co.,*
*Chicago, Ill.*

GENTLEMEN:—Your favor of the 21st, was duly received and we regret to state that it was mislaid and hence was the delay in replying.

We have to say in reference to the Stirling Boiler that we do not believe that you would make any mistake in putting them in. We have five of them something like 210 H. P. each, and will say that we are more than pleased with them and were we to put in more boilers, we would certainly put in the Stirling, as we believe there is nothing so good made.

Very Truly Yours,
THE NATIONAL SEWER PIPE COMPANY.
E. M. BUEL, *Sec'y,*

THE B. F. GOODRICH CO. AKRON RUBBER WORKS,

AKRON, OHIO, July 23rd, 1892.

*American Hoist and Derrick Co.,*

*48 S. Canal St., Chicago, Ill.*

DEAR SIRS:—Your esteemed favor of the 21st inst., is at hand. We put in a Stirling Boiler about a year ago, and have been running it steadily since, and so far have not had to pay out a dollar for repairs. The boiler is a 300 H. P. We had it open the first of this month and the tubes and drums were found to be as clean as when set up a year ago. We have never made any tests to determine how much steam we are getting from it, and as we run it in connection with ten other boilers we are unable to say how much this individual one does. Next week however, we expect to make a test as it is our intention to add another 300 H. P. boiler, and want to put in the Stirling if the one we have is doing what we believe it is. After the test we will be pleased to let you know how the boiler came out. With our experience up to date, we should pronounce the Stirling the best boiler we know anything about.

We trust the foregoing will be of service to you.

Yours Truly,

THE B. F. GOODRICH CO.

Below we name STIRLING PLANTS which we have installed for well-known firms.

## Offices and Public Buildings.

| | |
|---|---|
| Cutting Estate, New York | 60 H. P. |
| " " " " | 150 " |
| Despatch Publishing Co, Pittsburgh, Pa | 300 " |
| Presbyterian Hospital, New York | 300 " |
| " " " " 2nd order | 300 " |
| Lancashire Insurance Co., New York | 84 " |
| Imperial Fire Insurance Co | 34 " |
| James Callery & Co | 150 " |
| John Pettit | 100 " |
| D. O. Mills' Bld'g, San Francisco, Cal | 450 " |
| Mail and Express Bld'g, New York City | 450 " |
| Young Women's C. Ass'n Bld'g, Brooklyn, N. Y | 100 " |
| Times Bld'g, Pittsburgh, Pa | 412 " |
| Hartman Bldg., Grand Rapids, Mich | 125 " |

## Electric Plants.

| | |
|---|---|
| The Tiffin Illuminating Co., Tiffin, O | 150 H. P. |
| American Water Works and Guarantee Co., Pittsburgh, Pa. | 200 " |
| Lyon, Clements & Greenleaf, Wauseon, O | 150 " |
| Bell Telephone Co., Philadelphia, Pa | 142 " |
| Edison Electric Illuminating Co., Altoona, Pa | 200 " |
| " " " " " " 2nd order | 200 " |
| Hughes & Gawthorp, Pittsburgh, Pa | 60 " |
| Second Avenue Electric Railway Co,, Pittsburgh, Pa | 200 " |
| Wilkinsburg Electric Co | 150 " |
| " " " 2nd order | 450 " |
| Jamestown Street Railway Co., Jamestown. New York | 300 " |
| Akron Electric Co., Electric Lighting, Akron, O | 600 " |
| " " " " " " 2nd order | 200 " |
| Jones Bros. Electric Co., Cincinnati, O | 300 " |
| Auburn Mining Co., Electric Lighting, Auburn, Ind | 125 " |
| San Francisco & San Mateo R'y Co., San Francisco, Cal., (Electric) | 1,250 " |
| Conneaut Electric Co., Electric Lighting, Conneaut, O | 160 " |
| Los Angles Consolidated Electric R'y Co., Los Angles, Cal., | 1,500 " |
| Indiana Electric Co,, Indiana, Pa | 100 " |
| C. S. Robinson, Princeton, N. J | 100 " |

| | | |
|---|---|---|
| Canadian Copper Co., Cleveland, O | 100 | H. P. |
| North Carolina Iron & Steel Co., Greensboro, N. C | 500 | " |
| Carnegie, Phipps & Co., Pittsburgh, Pa | 1,200 | " |
| A. M. Byers & Co., Pittsburgh, Pa | 300 | " |
| Braddock Wire Co., Braddock, Pa | 600 | " |
| " " " Pittsburgh, Pa., 2nd order | 500 | " |
| Benwood Iron Works, Benwood, W. Va | 450 | " |
| Atlas Iron Works, San Fhancisco | 100 | " |
| Mahonging Valley Iron Co.. Youngstown, O | 100 | " |
| Lloyd Booth Co., Youngstown, O | 100 | " |
| Solid Steel Co., Alliance, O | 250 | " |
| " " " " " 2nd order | 250 | " |
| Falcon Iron & Nail Co., Niles, O | 250 | " |
| Eagle Iron & Steel Co., Irontown, O | 400 | " |
| Shook Anderson Mf'g Co., Pittsburgh, Pa | 75 | " |
| Clinton Iron & Steel Co., Pittsburgh, Pa | 125 | " |
| Joliet Enterprise Co., Joliet, Ill | 300 | " |
| " " " " " 2d order | 300 | " |
| Ashley Wire Co., Joliet, Ill | 700 | " |
| Phœnix Iron Co., Phœnixville, Pa | 300 | " |
| Alliquippa Steel Works, Alliquippa, Pa | 550 | " |
| St. Louis Wire Nail Co., St. Louis, Mo | 225 | " |
| American Tin Plate Co., Elwood, Ind | 1,000 | " |
| Bellaire Stamping Co., Harvey, Ill | 150 | " |
| Corning Steel Co.. Peoria, Ill | 1,000 | " |
| Midland Steel Co., Muncie, Ind | 550 | " |
| Maumee Rolling Mill Co., Toledo, Ohio | 550 | " |
| Indiana Iron Co., Muncie, Ind | 300 | " |
| Otis Steel Co., Ltd., Cleveland, Ohio | 1,500 | " |
| H. B. Milmine & Co., Toledo, Ohio | 75 | " |
| Standard Iron Co., Bridgeport, Ohio | 450 | " |
| Grand Bapids Brass Co., Grand Rapids, Mich | 100 | " |
| Pueblo Smelting and Refining Co., Pueblo, Col | 250 | " |
| West Superior Steel & Iron Co., West Superior, Wis | 450 | " |
| Compania Metalurgica Mexicana, San Luis, Potosi, Mexico | 450 | " |
| Minneapolis & St. Louis Smelting Co., Minneapolis, Minn | 200 | " |
| N. & G. Taylor, Tin Plate Works, Philadelphia, Pa | 150 | " |

## Miscellaneous.

| | | |
|---|---|---|
| Havermeyer & Elder Sugar Refining Co., New York | 45 | H. P. |
| National Sewer Pipe Co.. Akron, O | 1,065 | " |
| Diamond Match Co., Wabash, Ind | 300 | " |
| Litteaur Bros, Gloverville, New York | 60 | " |
| Land & River Improvement Co., West Superior, Wis | 60 | " |
| " " " " " " 2nd order | 100 | " |
| " " " " " " 3rd order | 100 | " |
| " " " " " " 4th order | 70 | " |

| | |
|---|---|
| Buena Vista Fire Clay Co., Buena Vista, Va | 100 H.P. |
| Marshall, Kennedy & Co., Allegheny, Pa | 600 " |
| Creedmoor Cartridge Co., Barberton, O | 100 " |
| Bissel & Co., Allegheny, Pa | 75 " |
| Arbuckle, Ryan & Co., Toledo, O | 300 " |
| Standard Oil Co., Cleveland, O | 400 " |
| Wyant Coal and Coke & Co., Eagle, W. Va | 100 " |
| The Bodley Wagon Co., Staunton, Va | 200 " |
| Niles Tool Works, Hamilton, O | 300 " |
| Cincinnati Water Works, Cincinnati, O | 1,200 " |
| Arcadia Coal Co, Arcadia, N. S | 150 " |
| " " " " 2d order | 150 " |
| " " " " 3d order | 550 " |
| Produce Cold Storage Exchange, Chicago | 600 " |
| Gillis & Geoghegan, New York | 125 " |
| American Alumina Co., New Portage, O | 200 " |
| L. S. & J. H. Lawless, Union Pearl Works, Brooklyn, N. Y. | 62½ " |
| B. F. Goodrich Co., Rubber Manufacturers, Akron, O | 300 " |
| Nordyke & Marmon Co., Mfrs. Milling Mach'y, Ind., Ind | 540 " |
| Merchants' Cold Storage Co., New York City | 600 " |
| Palmetto Fibre Co., Frederick, Md | 75 " |
| Heffner & Co., Flour Mill, Circleville, O | 125 " |
| Shaw Electric Crane Co., Muskegon, Mich | 100 " |
| Wm. C. Hamilton & Sons, Paper Mill, Phila | 300 " |
| Salina Paper Co., Salina, Kansas | 320 " |
| " " " " " 2nd order | 250 " |
| Emerson, Talcott & Co., Rockford, Ill | 200 " |
| Sioux City Engine Works, Sioux City | 224 " |
| Sioux Falls Milling Co., Sioux Falls, S. D | 80 " |
| M. C. Bullock Mf'g Co., Chicago | 100 " |
| Springside Coal Mining Co., Pana, Ill | 75 " |
| Illinois Chair Co., Rockford, Ill | 100 " |
| Mutual Wheel Co., Moline, Ill | 160 " |
| Capitol Wagon Co., Ionia, Mich | 160 " |
| The Watt Mining Car Wheel Co., Barnesville, O | 125 " |
| University of Michigan, Ann Arbor | 40 " |
| The Frash Soda Co., Cleveland, O | 800 " |
| Brechtol, Carney & Co., Toledo, O | 100 " |
| Griffin Enameled Brick Co., Perkiomen, Pa | 75 " |
| Glazier-Strong Oil Stove Co., Chelsea, Mich | 66 " |
| Eldred Mill Co., Jackson, Mich | 150 " |
| University of Nebraska, Lincoln | 100 " |
| Toledo Water Works, Toledo, O | 1,200 " |
| Beckman & Co., Cleveland, O | 300 " |
| Barrett Brewing Co,, " " | 150 " |
| Milburn Wagon Co., Toledo, O | 300 " |
| Eureka Milling Co., Sioux Falls, S. D | 75 " |
| Bonus Milner Milling Co., Sioux City, Ia | 60 " |
| J. H. Hertsche, Oatmeal Mill, Hamburg, Ia | 150 " |

| | |
|---|---|
| Cleveland Faucet Co., Cleveland, O | 100 H.P. |
| University of Illinois, Champaign, Ill | 50 " |
| Armour Packing Co., Kansas City | 1,000 " |
| " " " " " 2d order | 1,666 " |
| Storey Bros., Milwaukee, Wis | 100 " |
| J. B. Shepler, Ironville Paper Mill, Toledo, Ohio | 100 " |
| Maltase Mfg. Co. Brewery, Philadelphia, Pa | 100 " |
| New York Carbon Co., New York City | 75 " |
| United Salt Co., Cleveland, Ohio | 400 " |
| " " " " " 2nd order | 200 " |
| Crystal Ice Co., Youngstown, Ohio | 100 " |
| Knickerbocker Press, New York City | 100 " |
| Woolson Spice Mill, Toledo, Ohio | 125 " |
| The F. Gray Co., Piqua, Ohio | 200 " |
| Midland Hotel, Kansas City, Mo | 250 " |
| John Morrell & Co., Ottumwa, Ia | 200 " |
| Walsh De Roo Milling Co., Holland, Michigan | 175 " |
| Centennial Eureka Mining Co., Eureka, Utah | 450 " |
| Buckeye Brewing Co. Toledo, Ohio | 450 " |
| Akron Heating & Ventilating Co., Akron, Ohio | 75 " |
| Crookston Water Works Light & Power Co., Crookston, Minn | 150 " |
| West Michigan Furniture Co., Holland, Mich | 200 " |
| Clinton Steam Laundry, Clinton, Ia | 50 " |
| Columbus Woolen Manufacturing Co., Columbus, Ohio | 75 " |
| G. H. Hammond Packing Co., South Omaha, Neb | 400 " |
| American Cereal Co., Akron, Ohio | 400 " |
| International Nickel Mining Co., Riddles, Oregon | 300 " |
| National Home for D. V. S., Leavenworth, Kas | 600 " |
| United States Baking Co., Mansfield, Ohio | 50 " |
| Robinson Bros. & Co., Sewer Pipe Mfrs., Akron, Ohio | 400 " |
| Thompson & Johnson Roller Mill, Fisher, Minn | 125 " |
| Walter A. Wood Harvester Co., St. Paul, Minn | 600 " |
| Grand Rapids Gas Co., Grand Rapids | 100 " |
| Gœbel Brewing Co., Detroit, Mich | 250 " |

## Sales since going to Press.

| | |
|---|---|
| Armour Glue Works, Chicago | 1,050 H.P. |
| Armour & Co., Electric Plant, Chicago | 700 " |
| Armour Industrial School, Chicago | 400 " |
| Mobile Electric Light & Power Co., Mobile, Ala | 350 " |
| Spang Steel & Iron Co., Pittsburgh, Pa | 500 " |

Duty performed by four 212½ H. P. STIRLING BOILERS.

BRIDGEPORT, Ohio, June 19th, 1891.

*THE STIRLING COMPANY,*
*Chicago, Ill.*

GENTLEMEN:—In compliance with your request to furnish you data of the number, size and speed of engines operated by our 850 H. P. STIRLING BOILERS during a recent test made by us, I take pleasure in giving you the desired information, including also the work performed by each, together with such explanatory remarks as seem pertinent.

SCHEDULE.

Four Boilers. Total heating Surface, 9,760 square feet. Steam pressure, 120 lbs. Fuel used, "Aetna" slack and nut coal, fired by hand.

| No. of Engines. | Diameter. | Stroke. | Revolutions. | Kind of Valve. | Duty Performed Operating. | |
|---|---|---|---|---|---|---|
| 1 | 36″ | 66″ | 35 | Poppet | 1-20″ Bar Mill | 1 Stand Rolls |
| | | | | | 1-24″ Jobbing Sheet Mill | 2 " " |
| | | | | | 1-20″ Light Sheet Mill | 2 " " |
| 1 | 30″ | 66″ | 40 | Poppet | 1-3 High 20″ Muck Mill | 2 " " |
| | | | | | 1-Rotary Squeezer | |
| | | | | | 1-22″ Sheet Mill | 1 " " |
| | | | | | 1 Stand cold rolling sheet rolls | |
| 1 | 30″ | 42″ | 80 | Porter Allen | 1-16″ Bar Mill | 3 " " |
| | | | | | 1-9″ Guide Mill | 4 " " |
| 1 | 22″ | 24″ | 130 | Slide | 1-8″ Guide Mill | 4 " " |
| 2 | 14″ | 20″ | 120 | " | Operating Shears, etc. | |
| 1 | 9″ | 12″ | 150 | " | " " | |
| 1 | 9″ | 12″ | 130 | " | " " | |
| 2 | 9″ | 12″ | 120 | " | " " | |
| 1 | 8″ | 12″ | 165 | " | " " | |
| 1 | 14″ | 27″ | | " | Steam Lift | |
| 1 | 12″ | 21″ | 30 | " | Pump | |
| 1 | 12″ | 18″ | 35 | " | " | |
| 1 | 8″ | 45″ | 36 | " | Boiler Feed Pump | |

(Signed) B. M. CALDWELL, *Manager,*
*Aetna Iron and Steel Company.*

Test of two 150 H. P. STIRLING BOILERS, made at the works of DUQUESNE FORGE CO., Rankin, Pa., April 22, 1891.

| | |
|---|---|
| Average steam pressure | 100.8 lbs. |
| Average temperature of feed | 66° |
| Coal put in hoppers during experiment | 9,209 lbs. |
| Total refuse from coal | 1,451 " |
| Percentage of refuse | 15.8 % |
| Combustible consumed | 7,757 lbs. |

| | |
|---|---|
| Total weight of water actually evaporated at pressure of 100.8 lbs. from temperature of 66°, 68,112 feed, plus 2,332 lbs. difference in gauges | 70,444 lbs |
| Actual evaporation per lb. of coal charged | 7.64 " |
| Actual evaporation per lb. of combustible | 9.08 " |
| Evaporation per lb. of combustible from and at 212° | 10.77 " |
| H. P. developed by centennial standard | 514.7 " |
| Capacity of boilers with feed at 200° | 582.7 " |
| Increased efficiency | 11.3 % |
| Kind of Fuel | Pittsburgh Slack |

Respectfully submitted,

CHAS. HYDE, M. E.

Test of one 150 H. P. STIRLING BOILER made at TOLEDO BOLT AND NUT WORKS, Toledo, Ohio, May 20th, 1891.

| | |
|---|---|
| Average steam pressure | 195 lbs |
| Average temperature of feed water | 62° |
| Weight of coal charged | 6,286 lbs |
| Total refuse from coal | 682 " |
| Percentage of refuse | 10.8 % |
| Weight of combustible | 5,604 lbs |
| Weight of Water evaporated from 62° into steam at 105 lbs pressure | 50,800 " |
| Evaporation per lb. of coal charged | 8.08 " |
| Evaporation per lb. of coal charged from and at 212° | 9.7 " |
| Evaporation per lb. of combustible | 9.06 " |
| Evaporation per lb. of combustible from and at 212° | 10.87 " |
| H. P. developed by centennial standard | 222 " |
| Grate surface | 39 feet |
| Coal burnt per hour per ft. of grate | 20.2 lbs |
| Heating surface | 1,725 feet |
| Number of feet of heating surface per H. P. developed | 7.7 " |
| Duration of test | 8 hours |
| Rated capacity of boiler | 150 H. P. |
| Percentage above rated capacity | 48 % |

Respectfully submitted,

CHAS. HYDE, M. E.

Test of STIRLING BOILER at works of AETNA IRON AND STEEL Co. Bridgeport, Ohio, September 4, 1891.

NO. 2 BOILER. AIR PORTS OPEN.

| | |
|---|---|
| Duration of test | 4 hours |
| Temperature of feed water | 72° |
| Average pressure of steam | 105 lbs |
| Weight of coal charged | 5,722 " |
| Weight of water evaporated | 40,200 " |
| Weight of refuse | 1,360 " |
| Percentage of refuse | 23.7 % |
| Weight of combustible | 4,362 lbs |
| Evaporation per lb. of coal | 7.02 " |
| Evaporation per lb. of combustible | 9.2 " |
| Evaporation per lb. of coal from and at 212° | 8.28 " |
| Evaporation per lb. of combustible from and at 212° | 10.85 " |
| Grate surface | 56 feet |
| Coal burnt per ft. per hour | 25.5 lbs |
| Heating surface | 2,440 feet |
| Water evaporation per ft. per hour | 4.1 lbs |
| Rated capacity | 212½ H. P. |
| Horse power developed by centennial standard | 346 " |
| Per cent. above rating | 62.8 % |
| Draft in stack | 0.42 in. of water |
| Draft in furnace | 0.32 in. of water |
| Kind of fuel | Aetnaville slack coal, hand fired |

Respectfully submitted,

CHARLES HYDE, M. E.

Test of STIRLING BOILER at works of AETNA IRON AND STEEL CO. Bridgeport, Ohio, September 4, 1881.

NO. 2 BOILER. AIR PORTS CLOSED.

| | |
|---|---|
| Duration of test | 4 hours |
| Temperature of feed water | 72° F |
| Average pressure of steam | 120 " |
| Weight of coal charged | 4,456 lbs |
| Weight of water evaporated | 36,000 " |
| Weight of refuse | 1,035 " |
| Percentage of refuse | 23.2 % |
| Weight of combustible | 3,421 lbs |
| Evaporation per lb. of coal | 8.07 " |
| Evaporation per lb. of combustible | 10.05 " |
| Evaporation per lb. of coal from and at 212° | 9.05 " |
| Evaporation per lb. of combustible from and at 212° | 12.39 " |
| Grate Surface | 56 feet |
| Coal burnt per ft. per hour | 19.8 lbs |
| Heating surface | 2,440 feet |
| Water evaporated per ft. per hour | 3.7 lbs |
| Rated capacity | 212½ H. P. |
| Horse power developed by centennial standard | 309 " |
| Per cent. above rating | 54.4 % |
| Draft in stack | 0.4 in. of water |
| Draft in furnace | 0.28 in. of water |
| Temperature of gases in uptake | 790° |
| Kind of fuel | Aetnaville slack coal, hand fired |

Respectfully submitted,

CHAS. HYDE, M. E.

## BOILER TEST.

UNIVERSITY OF MICHIGAN,
ANN ARBOR, Mich., Feb. 4th, 1892.

*The Stirling Company,*
*Pullman Building, Chicago.*

GENTLEMEN:—I have the honor to submit a brief preliminary report of the test made on your boilers at the Edison Light Co.'s plant, in Grand Rapids, Michigan. Three tests were made, two to determine the efficiency, and one the capacity of the boilers. The accompanying tables contain the principal results of one of the efficiency tests and one of the capacity tests. The final report will contain full tables of data and results, including log-sheets and a description of the manner of making the tests.

In these tests all coal and water were weighed on platform scales previously tested with a standard weight, and all gauges and thermometers were carefully compared with the University standards.

The results obtained in these tests do not represent the best results obtainable with your boilers, but may be regarded as fair average results for continuous service, with the same grade of coal, carefully fired.

The coal used was "Montana" lump, which contained some fine coal, and portions of it considerable moisture. It was broken and used without being picked or sorted.

The firemen were the regular firemen employed by the Edison Light Company, and while they did their work well, they labored under the disadvantage of being obliged to handle the fires under conditions differing somewhat from those they were accustomed to.

During the efficiency test the tubes received no cleaning, and only the rear bank was blown just before the test began. The final report will show that the result of the latter part of the test did not differ materially from those of the first part.

In the efficiency tests the smoke-nozzle damper was about one-third open, and in the capacity test about two-thirds open. The draught and temperature of the escaping gases were taken just outside the smoke-nozzle.

It is to be remarked that the construction of these boilers is such that had the feed water been at a low temperature the efficiency would have been correspondingly increased, owing to a greater difference of temperature between the water in the rear bank of tubes and the escaping gases.

The calorimetric tests to determine the moisture or entrainment in the steam were made with usual care with a Barrus Universal Calorimeter, and gave for all of the tests about one-half of one per cent of moist-

ure. The moisture was not materially increased when the boiler was worked to its full capacity and the larger portion of the steam escaping through the safety valve.

The boiler appears to be easily managed, responds quickly to firing and has apparently a wide efficient range. In an emergency, with good draught, it can be forced to double its rated capacity without difficulty. The boiler is evidently well designed, efficient and powerful steam generator. I have the honor to remain,

Yours very truly,

(Signed) M. E. COOLEY.

---

Test of a 200 H. P. STIRLING BOILER at the plant of the EDISON LIGHT COMPANY, Grand Rapids, Michigan.

### RESULTS OF EFFICIENCY TEST.

| | |
|---|---|
| Date of trial, Jan. 25th, 1892. | |
| Duration of trial | 12 hours |

### DIMENSIONS AND PROPORTIONS.

| | |
|---|---|
| Grate surface, 6 ft. 10½ in. wide, 6 ft. long, area sq. feet | 50.25 feet |
| Water heating surface taken from builders tables, sq. feet | 2,300 " |
| Ratio of water heating surface to grate surface | 55.7 " |

### AVERAGE PRESSURE. POUNDS PER SQ. INCH.

| | |
|---|---|
| Steam pressure in boiler, by gauge | 111.719 lbs |
| Barometric pressure, 20.23 ins | 14.327 " |
| Absolute steam pressure | 126.046 " |
| Force of draught in inches of water | 0.781 " |

### AVERAGE TEMPERATURE: DEGREES FAHR.

| | |
|---|---|
| Of external air | 31.92° |
| Of fire room | 61.47° |
| Of steam | 344° |
| Of escaping gases | 419° |
| Of feed water | 171.61° |

### FUEL.

| | |
|---|---|
| Bituminous coal, "Montana" lump. | |
| Total amount fired | 9,565 lbs |
| Moisture in coal, per cent | 1.76 " |

| | | |
|---|---|---|
| Dry coal fired | 9,396 | lbs |
| Dry coal recovered from ash pit and furnace at end of test | 440 | " |
| Dry coal actually burned | 8,956 | " |
| Ashes and clinkers | 495 | " |
| Percentage of ashes and clinkers | 5.24 | % |
| Combustible | 8,463 | lbs |

## Results of Calorimetric Tests.

| | | |
|---|---|---|
| Moisture in steam, per cent | 0.454 | % |

## Water.

| | | |
|---|---|---|
| Total amount pumped into boiler | 81,458 | lbs |
| Water equally evaporated | 81,088 | " |
| Equivalent water evaporated into dry steam from and at 212° Fahr | 87,946.7 | " |

## Economic Evaporation.

| | | |
|---|---|---|
| Water actually evaporated per pound of dry coal burned, from actual pressure and temperature | 9.053 | lbs |
| Equivalent water evaporated per pound of dry coal burned, from and at 212° Fahr | 9.819 | " |
| Water actually evaporated per pound of combustible from actual pressure and temperature | 9.5807 | " |
| Equivalent water evaporated per pound of combustible from and at 212 ° Fahr | 10.391 | " |

## Rate of Combustion.

| | | |
|---|---|---|
| Dry coal actually burned, per hour | 746.388 | " |
| Per sq. foot of grate surface | 18.090 | " |
| Per sq. foot of heating surface | 0.3245 | " |

## Rate of Evaporation.

| | | |
|---|---|---|
| Water actually evaporated from and at 212° Fahr., pounds per hour | 7,328.9 | lbs |
| Per sq. foot of grate surface | 163.81 | " |
| Per sq. foot of heating surface | 2.938 | " |

## Commercial Horse Power.

| | | |
|---|---|---|
| On a basis of 30 pounds of water per hour evaparated from a temperature of 100° Fahr. into steam of 70 lbs. gauge pressure (34.5 pounds from and at 212° Fahr.) | 212.43 | H.P. |
| Horse power, builders rating at 11.5 sq, feet | 200 | " |
| Per cent. in excess of builders rating | 6.215 | " |

## RESULTS OF CAPACITY TEST.

Date of trial, January 24th, 1892.

| | |
|---|---|
| Duration of trial | 6 hours. |

### AVERAGE PRESSURE. POUNDS PER SQ. INCH.

| | |
|---|---|
| Steam pressure in boiler, by gauge | 110.65 lbs. |
| Barometric pressure, 29.38 ins. | 14.36 " |
| Absolute steam pressure | 125.01 " |
| Force of draught in inches of water | 0.599 " |

### AVERAGE TEMPERATURE. DEGREES FAHR.

| | |
|---|---|
| Of external air | 29.42° |
| Of fire room | 68.36° |
| Of steam | 343.38° |
| Of escaping gases | 455.55° |
| Of feed water | 166.30° |

### FUEL.

Bituminous Coal, "Montana" lump.

| | |
|---|---|
| Total amount fired | 8,759 lbs. |
| Moisture in coal | 1.76 % |
| Dry coal fired | 8,604 lbs. |
| Dry coal recovered from ash pit and furnace, estimated at 4.87 per cent | 419.06 " |
| Dry coal actually burned | 8,158 " |
| Ashes and clinkers estimated at 5.24 per cent | 450.89 lbs. |

### RESULTS OF CALORIMETRIC TESTS.

| | |
|---|---|
| Moisture in steam | 0.504 |

### WATER.

| | |
|---|---|
| Total amount pumped into boiler | 66,849 lbs. |
| Water actually evaporated | 66,512 " |
| Equivalent water evaporated into dry steam from and at 212° Fahr | 72,489 " |

### ECONOMIC EVAPORATION.

| | |
|---|---|
| Water actually evaporated per pound of dry coal burned from actual pressure and temperature | 8,157 lbs. |
| Equivalent water evaporated per pound of dry coal burned from and at 212° Fahr | .890 lbs. |
| Water actually evaporated per pound of combustible from actual pressure and temperature | 8,599 " |
| Equivalent water evaporated per pound of combustible from and at 212° Fahr | 9.372 " |

### Rate of Combustion.

| | | |
|---|---|---|
| Dry coal actually burned per hour | 1,358.99 | lbs |
| Per square foot grate surface | 23.945 | " |
| Per square foot heating surface | 0.59 | " |

### Rate of Evaporation.

| | | |
|---|---|---|
| Water actually evaporated from and at 212° Fahr., per hr. | 11,085 85 | " |
| Per square foot grate surface | 268.74 | " |
| Per square foot heating surface | 4.82 | " |

### Commercial Horse Power.

| | | |
|---|---|---|
| On basis of 30 pounds of water per hour evaporated from a temperature of 100° Fahr. into steam of 70 lbs. gauge pressure, (34.5 pounds from and at 212° Fahr | 350.2 | H. P. |
| Horse Power, builders rating, at 11.5 square feet per horse power | 200 | " |
| Per cent in excess of builders' rating | 75.1 | " |